Eco-Toxicology and Control of Indian Desert Gerbil, *Meriones hurrianae* (Jerdon)

VII. Relative number in relation to ecological factors

BY

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INTRODUCTION

There is no literature on the fluctuations of desert gerbil population except for some stray remarks by naturalists (Adams 1899 ; Blanford 1888-91 ; Jerdon 1867). To fill up this lacuna in our knowledge of the desert gerbil, attempts were made by us to undertake a population study on this species by the conventional capture-recapture technique, but the inherent trap-shyness of these rodents led us to abandon this technique. The present study was, therefore, done employing an indirect census method which only required the counting of freshly-opened burrow openings. Although this technique may have certain limitations, yet, for purposes of comparison between localities and between seasons, it has sufficient validity. This paper deals with the annual and seasonal numbers of the Indian desert gerbil, *Meriones hurrianae* (Jerdon) in the rainfall zones of the Rajasthan desert. An attempt has also been made to correlate gerbil numbers with various ecological factors.

METHODS

Number of Desert Gerbils :

It was observed that soon after venturing out of their burrows in the morning, the desert gerbils feed continuously for 30-45 minutes and do not indulge in burrow digging. This habit of the gerbil was utilized in formulating the census method which involved plugging of all the burrow openings in the evening after cessation of all surface activity followed by counting of all the freshly-opened burrow openings in the next morning within about half an hour of the start of their morning activity. Since during this period a gerbil is not likely to make more

than one burrow opening, each fresh burrow opening should represent one gerbil. This was checked in small plots by ocular counting before initiating the study. Plots measuring 90×90 m. were worked and divided in subplots of 7·5×7·5 m. In each subplot all the burrow openings were closed at evening and the freshly opened ones were counted next morning. The plots were situated at Jaisalmer and Chandan (180 mm. average annual rainfall); Barmer and Gadra Road (300 mm.); and Lachhmangarh and Palsana (450 mm.) representing the main rainfall zones of the Rajasthan desert. Census by burrow closing-opening method was carried out in summer (June), monsoon (August), post-monsoon (October), and winter (December) seasons. The trend of the population number being similar the data for both the work sites in each rainfall zone was pooled.

Vegetation : The vegetation was studied by the line intercept method (Cainfield 1941) in 8 transects at each work site in every season.

Soil Characteristics : The field density of soil was worked out by the British Standard Test No. 10 C and the per cent clay and permeability of the soil according to Darsy's Law method (SOIL MECHANICS FOR ROAD ENGINEERS, HMSO, London, 1961).

Climate : The climatic data have been taken from Pramanik & Hariharan (1952) and also from the Climatology section of the Institute.

Results and Discussion

Vegetation Cover :

The vegetation in all the three zones comprise chiefly of grasses, the most common species being: *Cenchrus ciliaris*, *Cenchrus setigerus*, *Cenchrus biflorus*, *Lasiurus sindicus*, *Aristida adscensionis*, *Eleusine compressa*, *Perotis hordeiformis*, *Chloris virgata*, *Cymbopogon jwarancusa*, *Digitaria marginata*, *Brachiaria ramosa* and *Dactyloctenium scindicum* etc. The other prominent species of plants occurring, in these sites are *Zizyphus nummularia*, *Tephrosia purpurea*, *Aerva tomentosa*, *Crotalaria burhia*, *Capparis aphylla*, *Calotropis procera*, *Pulicaria wightiana*, *Leptadenia pyro-technica*, *Calligonum polygonoides*, *Indigofera* sp. etc. The main tree species are : *Prosopis spicigera*, *P. juliflora*, *Acacia* spp., *Azadirachta indica*, *Salvadora oleoides*, etc. On the basis of frequency and density, the following plant communities were found at the three experimental sites : Barmer and Gadra Road (BG), *Cenchrus-Indigofera-Dactyloctenium-Aristida* community : Jaisalmer and Chandan (JC), *Eleusine-Aristida-Lasiurus* community ; Lachhmangarh and Palsana (LP), *Digitaria-Aristida-Cenchrus-Pulicaria* community.

The average annual plant cover at JC, BG and LP tracts was 6·66, 3·0, 2·69 per cent respectively and the grass cover was 1·19, 5·98, 1·80 per cent respectively. Table 2 shows the fluctuations in the total plant as well as grass covers during the various seasons. It will be observed that at BG and JC regions the cover was more in summer than in spring which was presumably due to early showers in the month of June.

Soil Characteristics : The field density of soils from LP and JC regions show very little difference (Table 3). These soils are denser than the soil at BG region since the field density of soils in the region is 1.36 gm./cm. as compared to 1·80 to 1·82 gm./cm. at the LP and JC regions respectively. The soils of JC region have the maximum amount of clay whereas the clay content is least in the soils of BG tract. Permeability of the soil for the seepage of water is maximum in the JC region and lowest in the BG tract.

Desert gerbil number :

Average annual number in three rainfall zones : The average annual number of the desert gerbils was maximum per experimental plot in the Barmer-Gadra Road tract and minimum at the Jaisalmer-Chandan tract (Table 1).

Table 1

Average annual number of desert gerbil in relation to climatic factors and vegetation

Rainfall zone	Average annual number of desert gerbil per 90 m. × 90 m. plot	Total plant cover %	Grass cover %	Rain-fall (mm.)	Mean maximum temp. °c	Mean minimum temp. °c	% Relative humidity of air 08.00 hrs.
Jaisalmer-Chandan	31	6·66	5·98	178	33·6	18·7	66
Barmer-Gadra Road	458	3·5	1·29	314	33·6	20·2	60
Lachhmangarh-Palsana	247	2·69	1·80	441	32·5	17·5	64

Seasonal fluctuations in gerbil numbers : The gerbil numbers show an annual trend which is identical for the Jaisalmer-Chandan and Lachhmangarh-Palsana regions. In these two tracts, their number is low in summer, slightly builds up during monsoon and reaches a peak in winter ; whereas at Barmer-Gadra Road tract, their number is minimum during summer, somewhat higher in winter, reaches a peak in spring and declines in summer (Table 2). The differences in number between

seasons were maximum in the JC region, which also has the maximum adverse climatic conditions as compared to the other two tracts.

TABLE 2

SEASONAL FLUCTUATIONS IN NUMBERS OF DESERT GERBIL IN RELATION TO CLIMATIC FACTORS AND VEGETATION

Season	Gerbil No. per 90 m. × 90 m.	% plant cover	% grass cover	Rainfall %/mm.	Max. temp. °c	Min. temp. °c	% Relative humidity of air at 08.00 hrs.
			Jaisalmer - Chandan region				
Monsoon (August)	12	9·97	9·2	62	34·6	24·9	93
Winter (December)	107	5·4	5·3	2	24·8	6·2	43
Spring (March)	3	4·5	3·95	3·6	31·7	16·9	55
Summer (June)	5.5	5·9	5·5	14	40·4	26·8	83
			Barmer - Gadra Road region				
Monsoon	110	42·2	1·30	86	33·6	24·9	82
Winter	560	1·7	0·67	2	26·7	11·9	56
Spring	795	2·2	0·68	3	32·3	17·9	58
Summer	367	3·9	2·57	24	39·7	26·8	73
			Lachhmangarh - Palsana region				
Monsoon	388	3·4	2·8	147	33·5	24·6	80
Winter	488	3·42	2·5	7	23·9	5·3	73
Spring	91	2·3	1·28	7	31·0	14·2	47
Summer	21	1·62	0·66	47	40·6	28·6	51

Average annual number of Desert Gerbil in relation to climatic factors : It is evident from Table 1 that the variation in the mean maximum and mean minimum temperatures at the three zones is only of the order of 1·6°C to 2·7°C whereas the gerbil number varies from 31 to 458. It, therefore, appears that the number of desert gerbils is not perhaps affected by temperature fluctuations in these three zones, which is expected since their burrows are comparatively cooler than the surrounding soil surface (Prakash *et al.* 1965). As the rodents develop hyperthermia due to exposure to the sun during their diurnal surface activity, they enter the burrows and the excess body heat is then intermittently unloaded to the cooler environment (Schmidt-Nielsen 1964; Fitzwater & Prakash 1969). It has, however, been observed that in JC tract where the gerbil number was the least per plot, the mean annual relative humidity was the highest and vice versa at BG region. It would appear therefore, that the population density of gerbils is inversely related to atmospheric relative humidity. However, the constancy of the humi-

dity conditions prevailing inside the burrows should be of more immediate consequence for population build-up in this species. The number of desert gerbils was found to be minimum in JC tract where the amount of annual precipitation is also the lowest. The next higher rainfall zone (BG), however, shows the maximum number of desert gerbils (Table 1). It, therefore, appears that the amount of precipitation is not an important factor for the density distribution in various zones. Another possibility is that a medium rainfall zone like Barmer-Gadra Road region, is more suitable for their population build up as it is neither too dry nor too wet.

Average annual number of desert gerbils in relation to vegetation : It was observed that the number of gerbils was higher in plots which had *Dactyloctenium scindicum, Aristida adscensionis, Lasiurus sindicus, Perotis indica, Digitaria marginata* and lower in plots having a high frequency of *Cenchrus biflorus* plants. The above mentioned grasses are preferred as food by the desert gerbils. Although it also feeds on *C. biflorus* but when the inflorescence ripens the awns become so sharp that they are repulsive to the rodents.

The average annual number of gerbils was minimum in JC tract where the total plant cover as well as the grass cover was the highest. In the two other tracts the higher gerbil numbers were associated with a lower plant as well as grass cover. This would look paradoxical since in areas with the higher plant cover food available should be more and a higher gerbil population should therefore, be expected. This paradox can be explained on the basis of their burrowing habit. The gerbils cannot easily dig their extensive burrows when they are confronted with the anastomosing, fibrous roots of grasses which form by far the majority of the vegetation of these tracts. Moreover, the extensive root systems make the soils more compact making burrowing more arduous. Our observations in the field also confirm that gerbils are densely distributed in open sandy plains as compared to heavily vegetated patches. Smith (1958) also observed that the dense vegetation is a limiting factor in the establishment of new dogtowns of the prairie dog, *Cynomys ludovicianus.*

Average annual number in relation to edaphic characteristics : A comparison of soil characteristics and the gerbil numbers (Tables 1 & 3) reveals that in the tracts where field density, permeability and clay per cent of soil was maximum (JC), the gerbil number was minimum, and vice versa (BG), which indicates that the gerbil numbers tend to be low where the soil is denser, has a higher permeability for seepage of water and is clayey in nature. Denser soils are usually more clayey and, therefore, burrowing should be difficult. It may, therefore, be one of the important factors affecting the relative abundance of desert gerbils in various localities. Another reason for their shunning the compact clayey soils

could be that more permeable soil will allow more seepage of rain water which would retain it for greater durations as compared to the looser soils which would probably disturb the micro-climatic balance inside the burrows.

TABLE 3

CHARACTERISTICS OF SOILS OF BG, LP AND JC REGIONS

Localities	Field density gm./cc.	% clay	Permeability gm./hr.
Jaisalmer-Chandan	1·80	5·3	0·8081
Barmer-Gadra Road	1·36	3·1	0·1622
Lachhmangarh-Palsana	1·82	4·5	0·3485

Seasonal fluctuations in gerbil numbers with respect to ecological factors : The desert gerbils stay during the periods of unfavourable climate inside the burrows which provide them with a comfortable and homogeneous micro-climate (Prakash, Kumbkarni & Krishnan 1965). Moreover, the desert gerbils are by behaviour adapted to avoid the extremes of heat and cold in the arid regions (Prakash 1962 ; Fitzwater & Prakash 1967). It is, therefore, expected that climatic fluctuations during a year may not play an important role in influencing the fluctuations in gerbil numbers. The soil characteristics are constant in all the seasons. Only vegetation cover could be one of the factors governing the seasonal fluctuations in gerbil numbers. However, it would appear from Table 2, that when the vegetation cover decreases the gerbil numbers increase. A similar situation was also reported by Ashby (1967) for *Apodemus sylvaticus* in Durham. The availability of green food, however, has been reported to have a direct enhancing effect on the rate of breeding of wild rabbits (Hughes & Rowley 1965). It was observed in a previous study (Prakash 1963) that the rate of littering of *Meriones hurrianae* also increases during the monsoon. This enhanced breeding which is apparently due to availability of green food, would explain the peak numbers met with during the winter in two zones, and during spring in Barmer-Gadra Road region. A plausible cause of low numbers during summer could be the low survival of the offsprings delivered after spring, as has been observed in the case of the desert hare, *Lepus nigricollis dayanus* (Prakash & Taneja 1969). Hence the seasonal fluctuations in gerbil numbers are influenced by the rate of breeding which is enhanced by the availability of green food during monsoon.

Rainwater flooding the burrows of fossorial rodents, is another factor which may matter in regulating the gerbil numbers. In all the experimental zones their numbers tended to increase after the monsoon

and as such it may be difficult to attribute any mortality of gerbil to this limiting factor. Moreover, the burrows of Indian desert gerbils are so extensive (Fitzwater & Prakash 1969) that the scanty rains of the desert region may not be sufficient to flood their burrow systems.

The role of predators, mostly snakes and predatory birds, in regulating the gerbil numbers is not clearly known but peak gerbil numbers are met with during the period when the snakes, their chief predators, hibernate. The gerbil population tends to fall after winter when reptiles are active.

To explain the seasonal fluctuations in rodent population is an intricate problem since, in nature, only one factor cannot be held responsible for these changes but several factors working together. Moreover, without studies on their behaviour, genetics and the endocrine mechanism, it is all the more difficult to work out the details of the population turnover.

Summary

The annual and seasonal numbers of Indian desert gerbil, *Meriones hurrianae* Jerdon, based on the counting of freshly-opened burrow openings, in three rainfall zones of Rajasthan desert, are described. Their numbers are related to soil characteristics, the population being less in clayey and compact soils. An inverse relationship between grass cover and population density has been observed. The seasonal fluctuations show an annual cycle, low during summer with a build up resulting in a high level during winter and spring. This population explosion may be mainly due to the higher rate of breeding during and after monsoon which is influenced by the availability of green food at this time.

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